Virginia Biodiversity Assessment - Part 1 Methodology

A Spatial Summary of Confirmed Biodiversity Ranked by Conservation Need

Submitted by the Virginia Department of Conservation and Recreation Division of Natural Heritage to the Virginia Coastal Zone Management Program
(NOAA Grant #NA06NOS4190241 Task93.03)
May 2008

Data Acquisition and Preliminary Processing

Land Cover

Land cover data were needed for the change detection analysis. National Land Cover Data (NLCD) 2001 were downloaded from the National Map and Coastal Change Analysis Program (C-CAP) 2005 data were downloaded from a National Oceanic and Atmospheric Administration website. These data were assembled in ArcInfo Grid so that the more recent C-CAP data would replace coincident data in the NLCD. The resulting layer had four classes of developed land as defined below:

> **Developed, Open Space** - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes
>
> **Developed, Low Intensity** - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.
>
> **Developed, Medium Intensity** - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.
>
> **Developed, High Intensity** - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to100 percent of the total cover.

These development classes were extracted from the layer, converted to a polygonal coverage, and then converted to a shapefile that was re-projected to the Virginia Lambert projection. This shapefile, referred to as the Development Layer, was used in the change analysis described later in this document to assess development encroachment on Department of Conservation and Recreation Division of Natural Heritage (DCR-DNH) Conservation Sites and Stream Conservation Units and Department of Game and Inland Fisheries (DGIF) Threatened and Endangered Waters (T&E Waters) and Wildlife Action Plan (WAP) Confirmed Reaches

DGIF T&E Waters and Confirmed Reaches

DGIF provided a shapefile for T&E Waters dated January 2006 and a geodatabase for Confirmed Reaches dated September 2006. These datasets were re-projected to Virginia Lambert. DGIF provided the following tables for use with the Confirmed Reaches geodatabase: Tier 1 Aquatic Species, Tier II and T&E Fish, and Tier II and T&E Mussels. These tables were joined using the Segment ID to the Aquatic Class Statewide layer in the geodatabase and the Confirmed and Biota Virginia ID fields were copied into

the layer. Eight hundred and forty reach segments containing confirmed species observations were then selected and exported to a shapefile named WAP_Confirmed_Reaches_All.shp. Potential reaches were excluded from the current assessment, but they will be included in VBP-Part II.

DGIF Species Observations

DGIF provided a shapefile, dated 25 February 2008, that contained Species Observations (SO) data derived from the ten sources described below:

Source 1: The Virginia Breeding Bird Atlas Project (BBA 1985-19889 (BBA)
Contribution: Birds were observed within 1/6th 7.5minute quadrangle blocks during the middle to late 1980s. Quad blocks polygons were created by VDGIF.

Source 2: Cold Water Stream Survey (CWSS)
Scale denominator: 100000
Contribution: VDGIF biologists sample a subset of all trout streams annually to monitor fish populations and assist with management decisions. CWSS records in this database contain species observation records. A separate GIS dataset contains classified stream reaches.

Source 3: WMA Bird Surveys (WMAsurv)
Contribution: Bird observations recorded during standarized Wildlife Management Area surveys conducted by VDGIF biologists. Points are recording using GPS.

Source 4: Rare bird sitings (Rarebird)
Contribution: Rare bird observations reported by reconized experts and listed on various websites or listservers. Location descriptions are digitized into points based on best available information.

Source 5: Mid-winter bald eagle survey (WintBAEG)
Media: chart
Scale denominator: 24000
Contribution: Mid-winter bald eagle observations recorded during annual surveys by VDGIF biologists. Eagle locations are marked on 1:24000 topographic maps and then digitized as points.

Source 6: Bald Eagle Nest Database (Eaglenest)
Media: chart
Scale denominator: 24000
Contribution: Annual bald eagle nest survey conducted by the Center for Conservation Biology at William and Mary, along with other reported inland nests. Nests locations are marked on 1:24000 topographic maps during survey flights and later digitized as points.

Source 7: VDGIF staff incidental observations (OBS)
Media: GPS locations
Contribution: ObsBook Database containing VDGIF biologist's incidental wildlife observations. Locations were recorded using GPS or digitized from location descriptions.

Source 8: VDGIF Scientific Collections, TE, and Salvage permit data (Collections)
Contribution: VDGIF Collections database containing wildlife species observation location information as reported by permittees hold a Scientific Collection, Threatened or Endangered Species, or Salvage permit. This database also includes records from VDGIF's warm water stream survey, JFISH and HERPS databases, and miscellaneous reports. Locations are reported by the permitee or digitized from permitee provided maps.

Source 9: Colonial Waterbird Locations (CWB)
Contribution: Virginia's Colonial Waterbird Database contains information on Virginia's breeding waterbird species. This application was developed in 1989 to continue data compilation activities discontinued by the Cornell Ornithological Laboratory. All Virginia-specific data compiled by

Cornell were read into this application. Subsequent State-collected colonial bird monitoring data are entered annually or as received. Refinement of colony location coordinates is ongoing.

Source 10: Colonial Waterbirds 2003 (CWB2003)
Media: maps
Scale denominator: 24000
Contribution: Results of 2003 survey of 446 colonial water bird colonies conducted by Center for Conservation Biology.

All tiered species (WAP Tiers I-IV) were extracted from this layer and exported to a new shapefile. This layer was filtered to preserve only the highest quality data in terms of species identification, spatial resolution, currentness, and relevance to this study. Sources 2, 3, 6, 7, 9, and 10 were retained for this assessment. The sources that were eliminated and the justifications for doing so are listed in Table 1.

Table 1. Justifications for elimination of DGIF species data by source.

Source	Justification for Elimination
1	These data are too coarse for this assessment.
4	There is no nest-site fidelity associated with these data and some of the species identifications are unreliable.
5	There is no nest-site fidelity associated with these data.
8	This source included records with unreliable species identifications and poor spatial accuracy, records for released animals, and too many records for common species (e.g. American Eel).

Also eliminated from this layer were records prior to 1977 (a cutoff date recommended by DGIF), records without dates, and records not within Virginia. The following fields were added to this layer to make it conform to the DCR-DNH Element Occurrences (EO) layer: SNAME, SCOMNAME, GRANK, SRANK, FEDSTAT, SPROT, EORANK, and TRACKED. Values were added to these fields using a table developed to crosswalk DCR-DNH and DGIF species databases. All observations in the DGIF species layer were assigned an EO-rank of "E" for "Verified Extant", which is equivalent to an EO-rank of "C" for "Fair estimated viability/ecological integrity" (see Appendix A).

DCR-DNH Conservation Sites and Stream Conservation Units

Conservation Sites were extracted from a layer of all DCR-DNH Biotic Sites, dated 6 December 2007, and exported to a new shapefile. Cave Sites were excluded from this shapefile because they were created recently and thus did not need to undergo the change analysis. However, Cave Sites were incorporated into VBA Sites after the change analysis. Stream Conservation Units (SCU) were extracted at a later date from a more current version of the Biotic Sites layer, dated 11 February 2008. The area of each site in each shapefile was calculated in square meters.

DCR-DNH Element Occurrences

The DCR-DNH Element Occurrences (EO) layer used for this assessment was dated 13 March 2008. Records were eliminated from this layer if they had general or minutes precision, no last observation date or a date prior to 1981, or EO-Ranks of D, D?, F, H, H?, NR, U, X or X? (see Appendix A). Records for reintroductions also were deleted. Recent records without precision information were retained because the precision field is an artifact of the Biological Conservation Database, which is a system no longer in use and which has been replaced by Biotics. Biotics uses representational accuracy instead of precision.

DCR-DNH Conservation Lands Database

A new attribute was added to the Conservation Lands database that separated lands based upon ownership and type of land protection by assigning them to one of four categories (Table 2).

Table 2. Categories used to separate lands based upon ownership and type of land protection.

Rank	Category	Definition
1	Priority	Conservation Lands with a BMI and LPS of "1". e.g. TNC Preserves and State Natural Area Preserves
2	Easement	Conservation Easements held by VOF, Land Trusts, and local PDR programs. e.g. VOF and TNC easements
3	Designation	State and Federal owned lands designated for conservation or recreation use. e.g. Wildlife Mgmt Areas and Recreation Areas managed by the Army COE
4	Ownership	State, Federal, Local and Land Trust owned conservation lands. e.g. National and State Forests and Parks

This attribute was used to create four layers, one for each category, that were later rejoined using a process of erasing and merging, starting with Rank = 4 and working upward as indicated in Table 2, to eliminate overlap among polygons while maintaining the best Biodiversity Management Intent (BMI) and Legal Protection Status (LPS). See Appendices B and C for descriptions of BMI and LPS. The resulting layer was dissolved on BMI and LPS to create the VBA Conservation Lands layer.

Change Analysis

DCR-DNH Conservation Sites

The Conservation Sites layer was intersected with the Development Layer to identify sites that were coincident with developed land covers. The area of each intersection was calculated in square meters. The resulting layer was dissolved on the site unique identifier, biodiversity rank, area, and development class fields, and the intersection areas were summed for each unique combination of attributes. The field of summed areas was divided by the total site area to estimate the proportion of each development class (see Land Cover section for class definitions) in each site. The resulting field was summed for each site to estimate the total proportion developed. These data were used to create two shapefiles: one showing the types of development intersecting each site and the other showing the total proportion developed of each site. The latter shapefile had all Conservation Sites weighted by the amount of development each site contained with a weight of 0 (virtually undeveloped) to 1 (entirely developed). To this layer also were added the remaining attributes form the intersection process, including the development proportion per class. Both layers facilitated review by the Chief Biologist as he determined whether to retain, modify, or eliminate each Conservation Sites. The proportion per development class allowed the Chief Biologist to gauge the intensity of development and the potential impacts on a species basis within sites.

Eight-two of the 1755 Conservation Sites in this analysis had weights between 0.3 and 1. The Chief Biologist compared the 82 sites to Virginia Base Mapping Program (VBMP) 2002 digital orthophotography and to a layer containing natural heritage resources. Within these sites, the EO-Ranks of twenty element occurrences were changed as indicated in Table 3.

Table 3. EO-Ranks changed as a result of the Change Detection Analysis.

Number of Occurrences	Old EO-Rank*	New EO-Rank*
1	B	X
2	C	H?

2	D	H?
1	D	H
3	D	X
1	E	H?
3	E	H
6	E	X
1	E	U

* See Appendix A for descriptions of EO-Ranks.

With a few exceptions, these 20 occurrences were re-ranked based on the fact that their habitat had been grossly altered between when the occurrences were last observed (generally between 1980 and 1995) and 2002 when the VBMP aerial photographs were collected. During this period, about 15 years on average, many of these occurrences were lost to housing or commercial development over all or most of the mapped occurrence.

As a result of these EO-Rank changes, 18 of the 82 (22%) Conservation Sites were lost. This included: 11 B5 sites, 5 B4 sites, and 2 B3 sites (see Appendix D). Figure 1 shows the locations of the lost Conservation Sites. Since the most heavily-developed 82 sites were chosen for this analysis, this alarming 22% rate would not hold in analysis of the less-developed 1673 sites. However, it is probable that 20-40 additional sites would be eliminated of the remaining sites for a total of about 40 to 60 eliminated sites (about 2 to 3% of the 1755 Conservation Sites).

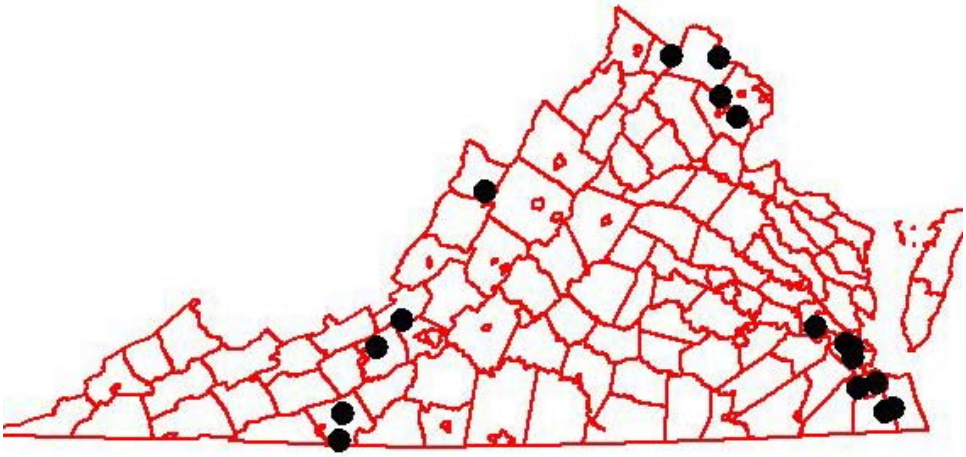


Figure 1. Locations of Conservation Sites lost largely to residential and commercial development.

It has been six years since the VBMP aerial photographs were collected and growth has exploded during this period, leaving one to wonder what other natural heritage resources have been lost since 2002. Also resulting from the change analysis, eleven site boundaries were modified and two were merged into larger adjacent sites.

DCR-DNH Stream Conservation Units

The SCU layer was intersected with the Development Layer and processed in a similar fashion to that of the Conservation Sites layer. SCUs that were at least 70% developed according to this process were compared to observation data to check for coincidence with recent EO and SO. If no rare species were documented in a feature within the last fifteen years, the SCU was eliminated.

Only one SCU exceeded the 70% threshold. It was created for a relic shell found in a stream that smelled like treated sewage back in 1995 and 1996. The EO-Rank of this occurrence was "D" (see Appendix A) and there were no other EO or SO associated with the SCU, thus it was removed from the DNH Biotics layer and its EO-Rank was converted to "H?". The Confirmed Reach with which this SCU coincided also was deleted.

The SCU for the Upper Roanoke River contained EO for three species: Orangefin Madtom, Roanoke Logperch (3 EO), and Dwarf Chinquapin Oak. The oak and one logperch record were EO-ranked "historic". The other two logperch records were ranked "extant" and the madtom was ranked "fair estimated viability". In order to retain these occurrences, the SCU was split into two sections and the downstream portion was deleted, saving the upstream portion of the main river and one tributary for these EO.

WAP Confirmed Reaches

The Confirmed Reaches layer was intersected with the Development Layer and processed the same way as the SCUs, except that the Confirmed Reaches were line segments and length was used instead of area to calculate the development proportions. Thirty-nine segments were at least 70% developed and 23 of these were deleted as a result of this analysis. The deleted segments included the downstream, highly developed sections of the Roanoke River and Mason Creek. These segments had no intersections with observations from the filtered DGIF species layer. The remaining of the 23 segments were compared to VBMP 2002 aerial photos and the DGIF species layer to determine whether they should be retained or deleted. Segments that were at least 70% developed and had no SO within the last 15 years were deleted, especially the downstream portions of such segments. Justifications for each deletion were recorded. Segments that exceed the development threshold but had recent observations were retained. Some of these impacted systems, such as those occurring over limestone, are very resilient and species can persist despite development due to the filtering capabilities of the substrate.

DGIF T&E Waters

The T&E Waters layer was intersected with the Development Layer and processed the same way as the Confirmed Reaches. Only one T&E Water exceeded the 70% development threshold and it was coincident with a Confirmed Reach that was already removed. This T&E Water, created for Tennessee Dace, and all other segments corresponding to segments deleted from the Confirmed Reaches layer were deleted.

VBA Sites

The aquatic layers edited due to the change analysis were compared to their corresponding original layers, to the proportion developed layers, and to each other to verify consistency in the deletion process. The Confirmed Reaches and T&E Waters layers, which were lines, were merged and then dissolved to remove overlap. The resulting layer was buffered to make polygons with a width of 200 meters. The SCU polygons also were buffered to a width of 200 meters, except for two Wood Turtle SCU that were allowed to retain their original width of 500-meters. The buffered layers were merged into a single layer and each feature was assigned a unique identifier (Aquatic Site ID).

Conservation Sites and Cave Sites were extracted from the Biotics Sites layer dated 13 March 2008, which was the version incorporating the changes resulting from the change analysis. Conservation Sites and Cave Sites were dissolved to remove the overlap among them and unique identifiers (Terrestrial Site ID) were assigned to the resulting features.

The aquatic and terrestrial sites were merged to create the VBA Sites layer. The aquatic and terrestrial sites within the new layer were not dissolved together, thus allowing them to be modeled separately.

VBA Confirmed Species

The filtered DCR-DNH EO and DGIF SO layers were merged and only those records that intersected VBA Sites were extracted to create the VBA Confirmed Species layer. The total area of each EO or SO, henceforth referred to collectively as "occurrence", was calculated in square meters and a unique identifier was assigned to each record in the Confirmed Species layer.

The VBA Sites layer was split into aquatic and terrestrial layers and then each was intersected with the Confirmed Species layer to create tables for assigning terrestrial and aquatic site identifiers to the Confirmed Species layer. The intersection layers were dissolved on the site and species identifiers, and the sum of the intersection areas were calculated to create the tables. Before processing them in MS Access, the tables were first summarized on species ID to create a frequency table to identify occurrences intersecting more than one VBA Site. The assignment tables were processed in MS Access so that, for large occurrences intersecting multiple VBA Sites, each occurrence would be assigned to the site with which it shared the greatest intersection area. The resulting tables were joined to the Confirmed Species layer and the site identifiers were copied into it.

In the Confirmed Species layer, the total area per occurrence was calculated in square meters and the EO-Rank, Global-Rank (G-Rank), and State-Rank (S-Rank) fields were converted to numbers. See Appendix E for information about G-Ranks and S-Ranks. Table 4 shows the values used to convert EO-Rank to

Table 4. The values used to convert EO-Rank to numbers.

EO-Rank*	Number
A	1.00
A?	1.25
AB	1.50
AC	2.00
B	2.00
B?	2.25
BC	2.50
C	3.00
C?	3.25
CD	3.50
E	3.00

* See Appendix A for descriptions of EO-Ranks.

numbers. Occurrences without G-Ranks (i.e. "Not Ranked" or "Un-rankable") were excluded from the layer and occurrences without S-Ranks were assigned the their corresponding G-Ranks. The resulting layer was ready for intersection with the DCR-DNH Conservation Lands database.

Proportions Conserved of Confirmed Species

The VBA Confirmed Species layer was intersected with the VBA Conservation Lands layer and the intersection areas were calculated. This layer was dissolved on occurrence identifier, occurrence area, LPS, and BMI, and the sums or the intersection areas were calculated. The summed areas were divided by occurrence areas to calculate the proportion conserved per occurrence and BMI-LPS combination.

These results, along with the BMI and LPS values, were copied into the Confirmed Species layer using joins. The frequency of occurrence identifiers in the dissolved layer was calculated and the summed intersections were themselves summed to obtain the total area conserved per occurrence, regardless of BMI and LPS. These results also were copied into the Confirmed Species layer using joins. In the Confirmed Species layer, zeros were entered for intersection area and frequency, and the number five was entered for BMI and LPS, for occurrences that did not intersect any conserved lands. Then, for the entire Confirmed Species layer, intersection area was divided by occurrence area to calculate the total proportion conserved per occurrence. Dissolves were used to simplify the Confirmed Species layer to unique combinations of the variables needed for the model while at the same time splitting it into aquatic and terrestrial subsets.

Numerous records had total proportions conserved of one or more, the latter due most likely to rounding errors associated with multiple intersections, such as intersections with two or more BMI-LPS combinations, or perhaps unresolved overlap in the Conservation Lands layer. The total proportions conserved were inverted in the model described below, thus these problematic records would have resulted in model outputs of zero. To prevent this, total proportions conserved greater than 0.9999985 were selected and adjusted as follows:

Adjusted Proportion Conserved = 1 – ([Maximum BMI] * 0.000002)

The multiplier (0.000002) was calculated using the smallest inverted proportion (1 - 0.999998) remaining in the table after the above selection was performed. In the final model calculations, the adjusted proportions resulted in very low inverted proportions that varied by BMI, leading to very low products after being multiplied by rank.

Prioritization Model

The aquatic and terrestrial tables were processed separately for the model. Unless specified, each MS Access query used the sort shown in Table 5. This sort results in tables that have the worst occurrences

Table 5. The sorting priority and types used for MS Access queries.

Priority	Field	Range	Sort Type
1	G-Rank	1 - 5	Descending
2	EO-Rank	1 - 3.5	Descending
3	S-Rank	1 - 5	Descending
4	BMI	1 - 5	Ascending
5	LPS	1 - 5	Ascending
6	Proportion Conserved	0 - 1	Descending
7	Aquatic or Terrestrial Site ID	# of sites	No Sort

(i.e. G-Rank = 5, EO-Rank = 3.5, and S-Rank = 5) with the best protection (i.e. BMI = 1, LPS = 1, and Proportion Conserved = 1) in the top rows and the best occurrences (i.e. G-Rank = 1, EO-Rank = 1, and S-Rank = 1) with the least protection (i.e. BMI = 5, LPS = 5, and Proportion Conserved = 0) in the bottom rows.

Queries were used to calculate unique codes representing all occurring variable combinations using the equation below:

UniqCode = [GrankNum]*1000000)+([EOrankNum]*100000)+([SrankNum]*100)+([BMINum]*10)+[LPSNum]+[PropConser]

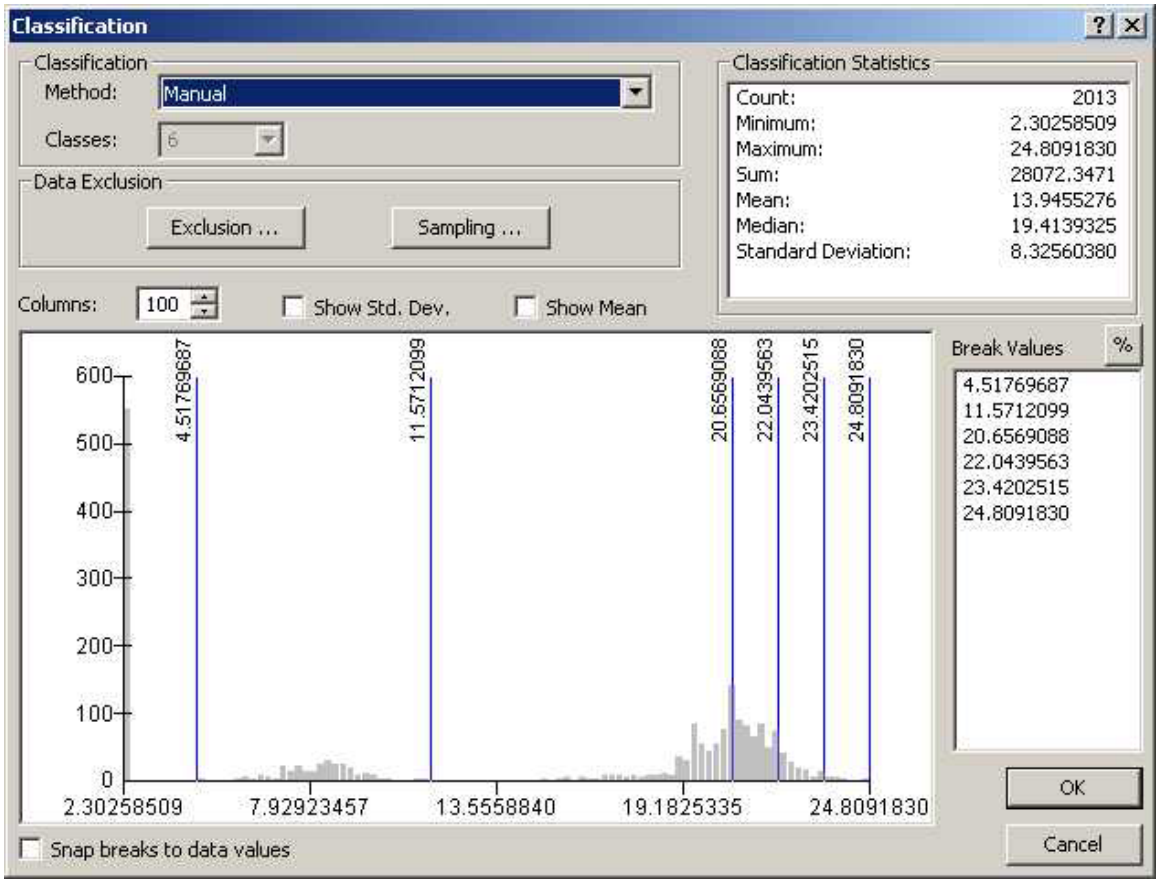
These tables were queried for unique values while excluding the site identification fields. A field named "Rank" was added to each table and was populated with sequential numbers, thus ranking the ordered unique combinations of variables. These tables were related back to the main tables using the unique codes so that the ranks could be added to the main tables.

The tables were exported to MS Excel, where the proportions conserved were inverted and multiplied by the ranks to calculate the Occurrence Conservation Need Scores (OCNS). Despite earlier efforts to avoid OCNS of zero, rounding of very small numbers resulted in many zeros. These results were converted to a value of 0.00001, which was one-tenth of the lowest real model output. The justification for this was that known occurrences and sites, even if they scored zero in this model, had value at least greater than background (i.e. areas of the state for which we have either no information or abundant negative data).

The OCNS tables were imported to ArcMap and summarized on Terrestrial Site ID or Aquatic Site ID to calculate the Site Conservation Need Scores (SCNS). The ranges of aquatic and terrestrial SCNS were very similar (maximum TSCNS = 52456, maximum ASCNS = 59496), thus they were combined into a single field without first expanding the range of either one.

The distribution of SCNS was severely skewed right, therefore transformation was required to normalize the distribution before classifying it. Log Base 10 transformations are useful for correcting this type of skew. In order for the lowest logged output to be 1, the distribution was scaled so that the minimum SCNS became 10. The log transformation was performed on the scaled SCNS. The resulting distribution and classification can be viewed in Figure 2.

Figure 2. The SCNS distribution after it was transformed using Log Base 10 and the resulting classification.



The class breaks were assigned manually and are described in Table 6. These classes of the continuous SCNS were converted to integers in a new field called Biodiversity Conservation Need (BCN). The values range form 1 for "Moderate" to 6 for "Critical" BCN. The frequency of these classes is shown in Table 7.

Table 6. Breaks used to classify SCNS.

Class	Description
1	Contains the spike of near-zero values
2	Includes the first small bell-shaped peak
3	Includes values below the mean of the "real" distribution
4 - 6	Each of these classes is an equal slice of values above the mean of the "real" distribution

Table 7. The classes of Biodiversity Conservation Need and their frequency.

Biodiversity Conservation Need	Frequency
1 -- Moderate	551
2	270
3	522
4	511
5	142
6 -- Critical	17

Figures 3 and 4 show Biodiversity Conservation Need throughout the Commonwealth and within the Coastal Zone.

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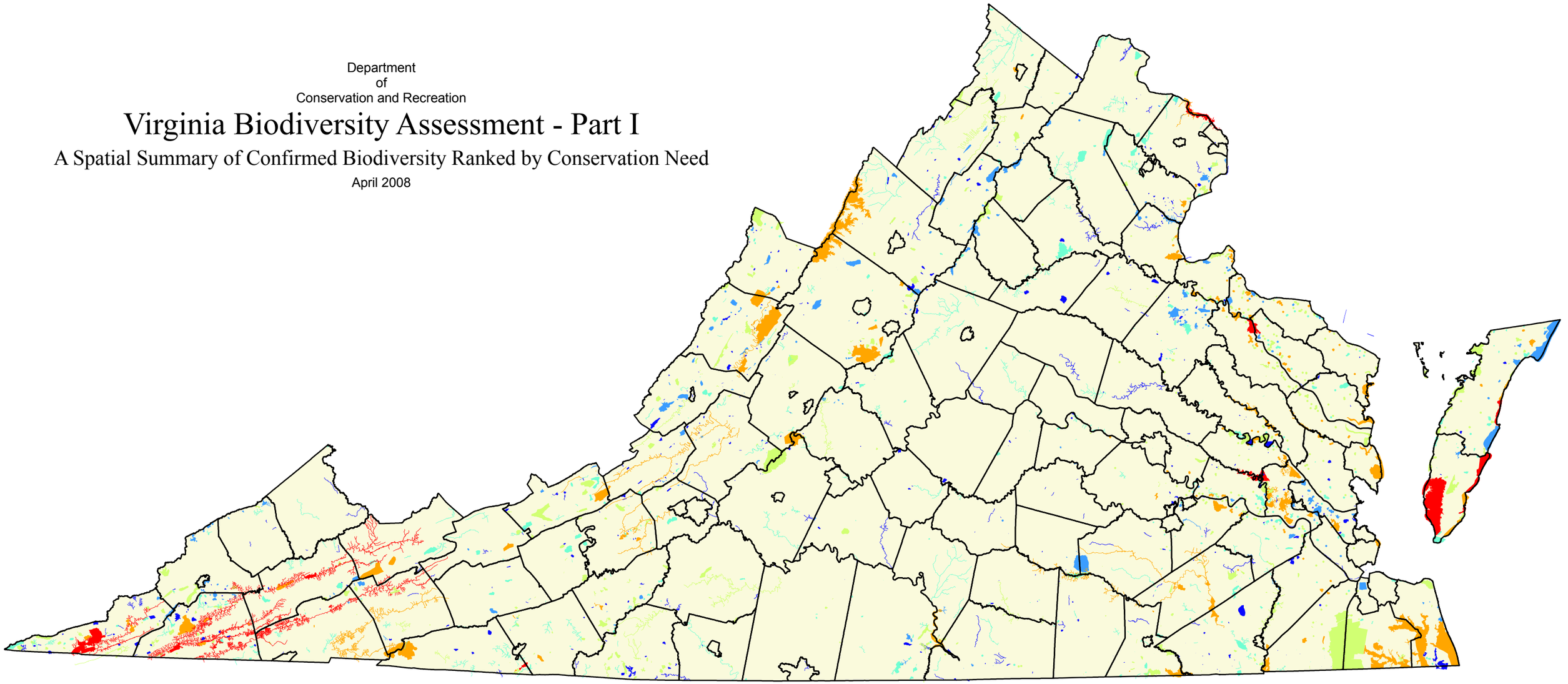
Virginia Biodiversity Assessment - Part I

A Spatial Summary of Confirmed Biodiversity Ranked by Conservation Need

April 2008



Biodiversity Conservation Need

- 6 -- Critical
- 5
- 4
- 3
- 2
- 1 -- Moderate

50 25 0 50 100 Kilometers

50 25 0 50 100 Miles

This project was funded by the Virginia Land Conservation Foundation and by the National Oceanic and Atmospheric Administration through the Virginia Coastal Zone Management Program in the Department of Environmental Quality (FY2006 Task 93.03, NOAA Grant #NA06NOS4190241)

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Virginia Natural Heritage Program

Virginia Coastal Zone MANAGEMENT PROGRAM

VLCF Virginia Land Conservation Foundation

Sources:

DCR - Natural Heritage Element Occurrences, Conservation Sites, Stream Conservation Units, and Cave Sites

DGIF - Species Observations*, Wildlife Action Plan Confirmed Reaches, and Threatened and Endangered Waters.
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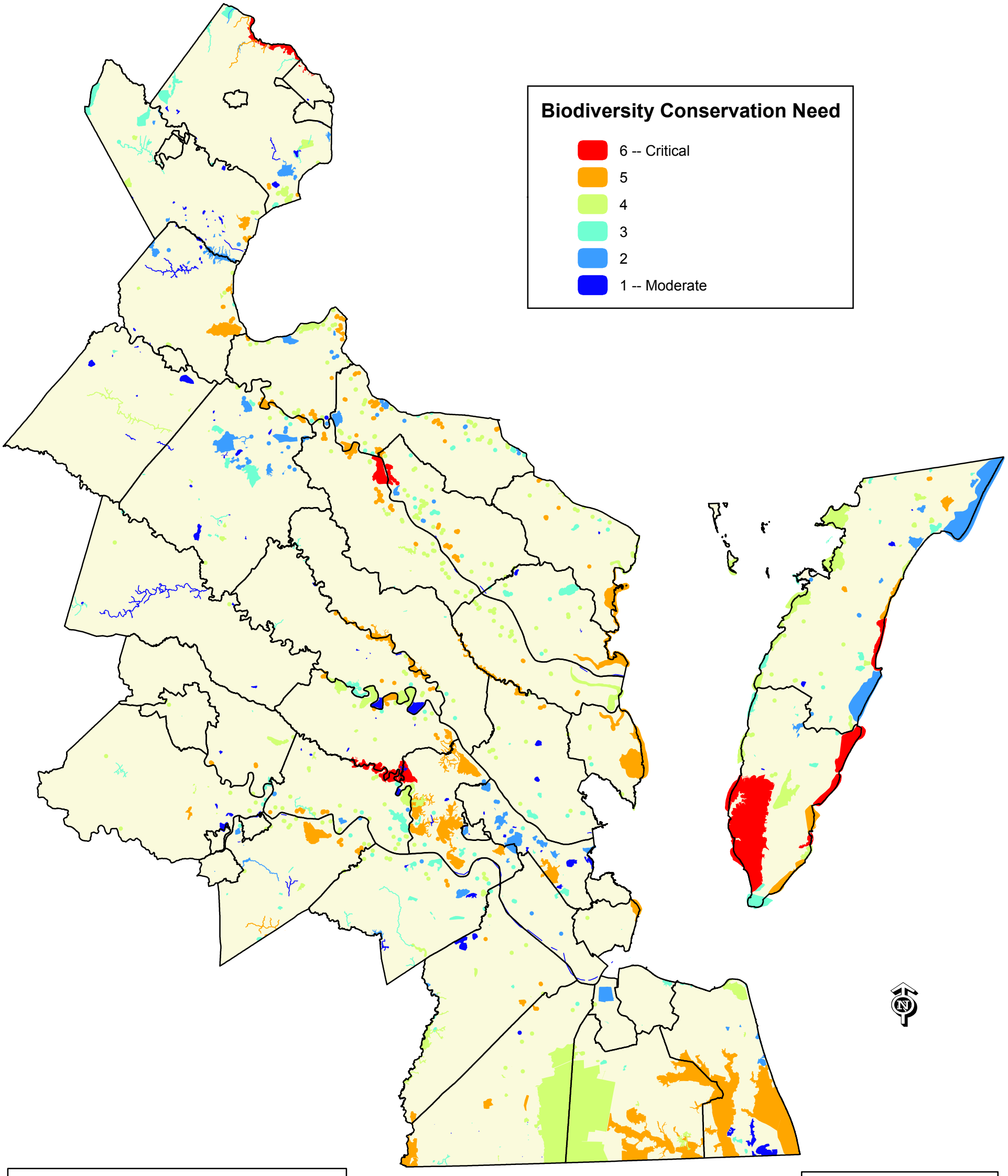

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Appendix A

Element Occurrence Rank:
A - Excellent estimated viability/ecological integrity
A? - Possibly excellent estimated viability/ecological integrity
AB - Excellent or good estimated viability/ecological integrity
AC - Excellent, good, or fair estimated viability/ecological integrity
B - Good estimated viability/ecological integrity
B? - Possibly good estimated viability/ecological integrity
BC - Good or fair estimated viability/ecological integrity
BD - Good, fair, or poor estimated viability/ecological integrity
C - Fair estimated viability/ecological integrity
C? - Possibly fair estimated viability/ecological integrity
CD - Fair or poor estimated viability/ecological integrity
D - Poor estimated viability/ecological integrity
D? - Possibly poor estimated viability/ecological integrity
E - Verified extant (viability/ecological integrity not assessed)
F - Failed to find
F? - Possibly failed to find
H - Historical
H? - Possibly historical
X - Extirpated
X? - Possibly extirpated
U - Unrankable
NR - Not ranked

Appendix B

Biodiversity Management Intent:

1. *Specifically Designated for the Protection of Plant and Animal Communities*. An area managed to maintain and protect natural plant and animal communities within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

Examples include Wilderness Areas, National Forest Special Biological Areas, Research Natural Areas and Roadless Areas, Nature Conservancy Preserves, State Natural Area Preserves, and National and State Parks with a nature focus.

2. *Designated for the Conservation of Plant and Animal Communities with Limited Impacts Permitted*. An area managed to maintain a natural state, the use of which leads to minor degradation.

Examples include many National Fish and Wildlife Refuges, most State Parks, State Wildlife Management Areas, Virginia Outdoors Foundation properties, and natural Stream Valley Parks. The managed area includes an area less than 10% in human-introduced vegetation and improvements.

3. *Designated for Natural Resource Conservation and Recreation Use.* An area managed for multiple conservation and recreation uses but only incidentally to protect natural plant and animal communities.

Examples include most National Forest matrix lands which are used to generate timber, some State Parks with a cultural resource focus such as Staunton River, Sailor's Creek Battlefield, and New River Trail Parks, private timber lands which are not converted from natural forests when logged and that have a chance to become natural forests before they are logged again, private lands under open space easement that may include a Virginia Department of Forestry timber management plan.

4. *Unknown Management Intent.* Managed Areas for which management intent is currently unknown. These lands need to be investigated further before a management status rank is assigned.

5. *No Designation or Management for Conservation of Natural Conditions.* An area having no management or conservation direction to sustain, restore or enhance natural land cover values.

Examples include State or National Parks and Monuments in urban settings, many County, City, and Regional Parks, sportsman club properties, private agricultural lands and lands used for commodity timberland production using non-native species or monocultures, residential lands, and urban lands.

Appendix C

Legal Protection Status:

1. *Permanent Protection.* An area benefiting from permanent, legal protection. Conversion of the managed area to a more intense, non-conservation use may be prohibited by law. Removal of a property from this status may require judicial or legislative action or administrative action requiring public input. The area is government or institutionally owned or managed (e.g., for certain easements) under permanent legal protection.

    Examples include most National Parks, Wilderness Areas, and National Wildlife Refuges, National Forests, Department of Defense lands, State Forests, State Parks, State Natural Area Preserves, County and City Parks with Land & Water Conservation Funds or permanent deed restrictions, publicly owned lands that lack deed restrictions but the public expects to remain permanently designated, Nature Conservancy Preserves, Permanent Conservation Easements.

2. *Long Term Protection.* An area with a binding and long-term protective designation. These designations are established through regulations, legally recognized term easements or term deed restrictions, or temporary management agreements. The land should be secure for a significant amount of time (5-15 years), but programs or regulations are subject to change or cancellation at any time.

    Examples are lands set aside by a federal forest plan as a Special Interest Area or Special Biological Area, a long-term (but not permanent) conservation easement, Ag-Forest districts, and others.

3. *Voluntary Protection.* An area voluntarily placed in conservation use by the owner. Designation is not backed by any regulation, incentive payment, or easement.

    Examples include voluntary Natural Area Registry properties and voluntary protection by a private landowner or timber company (IP's Special Places in the Forest).

4. *Unknown.* Legal protection status is unknown.

5. *No Protection.* No enforceable policy or regulation or landowner action governs the current or future conservation use of the managed area.

Appendix D

Conservation Sites Ranking

B-rank is a rating of the significance of the conservation site based on presence and number of natural heritage resources; on a scale of 1-5, 1 being most significant. Sites are also coded to reflect the presence/absence of federally/state listed species:

Conservation Site Ranks	Legal Status of Sites
B1 - Outstanding significance	FL – Federally listed species present
B2 - Very High significance	SL – State listed species present
B3 - High significance	NL – No listed species present
B4 - Moderate significance	
B5 - Of general Biodiversity significance	

Appendix E

Definitions of Abbreviations used on Natural Heritage Resource Lists

The following ranks are used by the Virginia Department of Conservation and Recreation to set protection priorities for natural heritage resources. Natural Heritage Resources, or "NHR's," are rare plant and animal species, rare and exemplary natural communities, and significant geologic features. The criterion for ranking NHR's is the number of populations or occurrences, i.e. the number of known distinct localities; the number of individuals in existence at each locality or, if a highly mobile organism (e.g., sea turtles, many birds, and butterflies), the total number of individuals; the quality of the occurrences, the number of protected occurrences; and threats.

- **S1** - Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. Typically 5 or fewer populations or occurrences; or very few remaining individuals (<1000).
- **S2** - Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. Typically 6 to 20 populations or occurrences or few remaining individuals (1,000 to 3,000).
- **S3** - Vulnerable in the state either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21 to 100 populations or occurrences (1,000 to 3,000).
- **S4** - Apparently secure; Uncommon but not rare, and usually widespread in the state. Possible cause of long-term concern. Usually>100 populations or occurrences and more than 10,000 individuals.
- **S5** - Secure; Common, widespread and abundant in the state. Essentially ineradicable under present conditions. Typically with considerably more than 100 populations or occurrences and more than 10,000 individuals.
- **S#B** - Breeding status of an animal within the state
- **S#N** - Non-breeding status of animal within the state. Usually applied to winter resident species.
- **S#?** - Inexact or uncertain numeric rank.
- **SH** - Possibly extirpated (Historical). Historically known from the state, but not verified for an extended period, usually > 15 years; this rank is used primarily when inventory has been attempted recently.
- **S#S#**- Range rank; A numeric range rank, (e.g. S2S3) is used to indicate the range of uncertainty about the exact status of the element. Ranges cannot skip more than one rank.
- **SU** - Unrankable; Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
- **SNR**- Unranked; state rank not yet assessed.
- **SX** - Presumed extirpated from the state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
- **SNA**- A conservation status rank is not applicable because the element is not a suitable target for conservation activities.

Global Ranks are similar, but refer to a species' rarity throughout its total range. Global ranks are denoted with a "G" followed by a character. Note GX means the element is presumed extinct throughout its range, not relocated despite intensive searches of historical sites/appropriate

habitat, and virtually no likelihood that it will be rediscovered. A "Q" in a rank indicates that a taxonomic question concerning that species exists. Ranks for subspecies are denoted with a "T". The global and state ranks combined (e.g. G2/S1) give an instant grasp of a species' known rarity.

These ranks should not be interpreted as legal designations.